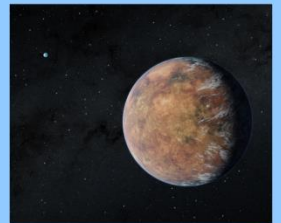


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S2 EP6: Journey to Exoplanets Beyond Our Solar Shore

What are Exoplanets?

EPISODE 6



**ASTROPHYSICS: DEEP IN THE SPACE
WITH MAANVINDER PILANIA**

Maanvinder Pania

Astrophysics: Deep In The Space With
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Journey to Exoplanets Beyond Our Solar Shore

Welcome back friends for another episode of this astronomy podcast, I'm your host Maanvinder and today we're going on a new journey to the world of exoplanets that are way more complex than the planets in our solar system.

Our universe is huge and expanding, with billions of galaxies which have billions of stars and so billions of planets in the universe. The only one that we know where life exist is our own home planet Earth. Earlier as you might know peoples used to believe that planets only exist in our solar system until Copernicus changed when he came up with his theory that Earth revolves around the Sun. Updating this same theory in sixteenth century Italian Philosopher Giordano Bruno put forward his idea stating fixed stars are also like the Sun which have their own planets. In Astronomy, there is a different term for such planets which do not revolve around the Sun and are called exoplanets, meaning planets outside our solar system. Later in the 20th century, astronomers knew that exoplanets exist but they were yet to be discovered. The first confirmed exoplanet was discovered in 1992. By 1 July 2024, 6660 exoplanets were discovered through various methods that I will later talk about in this episode. But first let's talk about their formation.

Exoplanets are no different from planets in our solar system when it comes to their formation. However, they might change from one type to another because of some extreme conditions. Exoplanets just like planets are born in a nebula where star formation takes place. They are formed from the leftovers of a star which has died and when a new star is born. The remaining dust and gas that could not accumulate into a star because they lack mass enough to turn into a star, end up becoming a planet or in this case an exoplanet.

According to NASA, exoplanets can be categorized into gas giant, Neptunian, Super Earth and Terrestrial. However, they can also be sub categorized based on several factors and can also be categorized into other types but those four are the main. They come in different sizes and shapes like WASP-12b (an rugby ball shaped exoplanet, which is being devoured by its host star), exoplanets that orbit two stars like Kepler-16b (the stars it orbits are smaller than our Sun; one is 60% the mass of Sun and other only 20%). They can boil you easily if melting a metal and glass is easy for them and the best example is 55 Cancri-e. There are planets which are wandering alone in the vastness of space. Now I will tell you about those main 4 categories, astronomers divides exoplanets in to have a better understanding of their formation.

1. **Gas Giant-** These are planets that are the size of our local neighbors Jupiter and Saturn. In fact, they are also gas giants and it is true that gas giants are also found outside our solar system. They are gaseous. Now if I talk about the sub

category, then Hot Jupiter's are the best example of it. They are basically the gas giants that are tidally locked with their stars, they are gaseous and are scorching heat. They formed in the cold regions but later migrated into the system and are now tidally locked; meaning one side is burning hell and other chilling cold. I can also categorize it into another type, say Ultra Hot Jupiter. They are even hotter than Hot Jupiter's are and are mostly being devoured by their host stars. For better understanding of our universe, astronomers divide them into different categories to understand more about them. One example of Gas Giant will be Kepler-16b. If you were paying attention then you would know I talked about it earlier. It orbits two stars and was discovered in 2011 using NASA's Kepler Spacecraft by transit method. It is cold, gaseous and composed of rocks, located about 200 light years from the Earth.

2. **Super Earth-** They are massive than Earth but smaller than Neptune. They can be terrestrial or full of water. They become huge because they quickly attain the thick atmosphere of hydrogen and helium. The two best examples of Super Earth that comes in my mind are 55 Cancri-e and Kepler-22b. The earlier is tidally locked with its host star and it is so hot that its rocks get vaporized only to rain back as lava on the night side while later is a water planet whose more than 95% surface is believed to be Ocean as it is located in its star's habitable zone where liquid water can exist.
3. **Neptunian Planet-** They are similar in size to Neptune and Uranus and have thick hydrogen and helium atmosphere with a rocky core. They can be sub categorized into Mini-Neptunes, which are smaller than Neptune but larger than Earth. They can become super-earth if they lose their atmosphere. It might not seem the case for other planets but it surely fits in the case of Neptunes. In a rare [discovery in 2022](#), astronomers at W.M Keck Observatory and those using NASA's Hubble Space Telescope discovered two different mini-Neptunes that were losing their atmospheres turning into super earth. I also talked about this discovery last season. As I mentioned earlier about super earth and mini-Neptune, there is one thing in common that they both are bigger than Earth but smaller than Neptune. That brings us to the conclusion that Super Earth can also form when a mini-Neptune loses its atmosphere due to radiation from their host star. In fact the smaller planets in many star systems are believed to be Mini Neptunes who lost their atmospheres due to their host star's intense radiation.
4. **Terrestrial-** rocky planets who failed to have thick atmospheres of hydrogen and helium or if they had a thick atmosphere but lost it because they lost their magnetic field just like Mars in our solar system and do not confuse it with the case of mini-Neptune losing atmosphere to become super earth because they are smaller than the Super Earth.

Other types of these exoplanets include:

1. **Puffy Planets**- gas giants with a puffy appearance just like a cotton candy. I will tell you about these in more details in one of upcoming episode.
2. **Rogue Planets**- planets that do not orbit a star and drift through the space.

There are many methods to detect the presence of an exoplanet. One of the best methods is called Transit Method in which astronomers uses the dip in the curve of light coming from a star to detect an exoplanet. Say there is a planet far from Earth orbiting its host star and we don't know that there is a planet orbiting around that star. In order to find out, we will point our probe in this case let's take NASA's TESS mission, towards a star and we wait for the dip in the light that comes from the star. When an exoplanet passes in front of a star, it causes the light coming from the star to dip, which is then used to determine the size of the planet. This method is called transit method and is one of the most effectively used methods to discover an exoplanet by the science community.

Another method is Pulsar Timing. Actually this was the method which made the first detection of an exoplanet surrounding a Pulsar. In this method if a planet is orbiting a pulsar, then it will cause anomalies in the timing of observed radio pulses that is the radio waves that it emits regularly as it rotates. The next popular method after transit method is Radial Velocity or Doppler method. In this method, astronomers use the light coming from the star. Still didn't understand it. Okay so think about the space time curvature and if you did the experiment or at least saw a video of it that how when planets move around a star, they causes the star to wobble. When a planet orbits a star, their gravity causes their star to wobble and this affects the light coming from the star. If a star is moving towards then the light will be blue and if moving away, then red. That's the basic science of Doppler shift here. By noticing the color change in the star's light spectrum, astronomers can detect the wobble thus the presence of an exoplanet.

There's one other method that I want to talk about and it is called Gravitational Microlensing. You may have heard about it when James Webb Space Telescope released its first images which surprised everyone and in one of the image, gravitational lensing can be seen very clearly. The image is called [Webb's First Deep Field](#) and shows many objects like stars, galaxy clusters, and distorted background galaxies behind the galaxy star. According to Einstein's theory of general relativity, massive objects can bend light and it is called Gravitational Lensing. When a planet passes in front of a distant star, the planet's gravity bends and magnifies the light from the background star. This causes the background star to temporarily brighten, which can be detected by telescopes. By studying the pattern and amount of brightening, astronomers can determine the presence, mass and even distance of the exoplanet.

There are so many methods to discover exoplanets but these were one of the mostly used and successful ones.

What never fails to amaze me is the fact that there must be an exoplanet where life exists. In fact, [1 in 5 Sun](#) like star have one Earth sized planet in their habitable zone. Okay now I will tell you about the recent news about an exoplanet called [HD 189733b](#), located in the constellation Vulpecula about 64.5 light years from our solar system. Recently NASA's James Webb Space Telescope has detected the presence of Hydrogen Sulfide, a gas which smells like an rotten egg. The gas is also an indicator of presence of life. However, in case of this planet it is not true. Wanna know why? Then close your eyes and imagine what I'm about to tell you. You are standing on a planet which is so close to its star that it is tidally locked. The dayside of the planet always faces the star and night side always faces out into the space. The dayside is hot enough to evaporate glass and when this happens, the high speed winds carries away that molten to night side where it condenses and rain down as glass. Would you be able to survive on a planet where instead of your normal rain like on Earth, rains glass that can pierce through your body. I would not dare to spend a minute on that planet. However, it will be totally impossible to stand on it as the planet is a gas giant and to be clearer it is a Hot Jupiter. Remember I told you earlier about this type of exoplanets. So in conclusion the discovery of Hydrogen Sulfide means the planet will smell an rotten egg. This gas makes most of the planet's atmosphere and don't get attracted towards its beautiful blue color because that comes from clouds of glass. This has however is also found on Jupiter but it is one of the first detection on an exoplanet which is crucial in understanding the atmosphere, and life of a planet. HD 189733 b was discovered in 2005 using a method called radial velocity that I talked about earlier in the episode. It has an [orbital period of 2.2 days](#) because of it being so close to its star.

that is from me for this episode and part 1 of season 2, stay tuned in for part-2 coming July 21st with brand new episodes!!!

Archive Blog: <https://astromaanvinder.blogspot.com>